ch. 3, b stoichiometry

- is the quantative relationship between the amount of chemicals in a Rx
  - ↑ # mol or # g
  - ↑ reactants & products
- able to determine
  - amount of given amount of reactants (↑ products)
  - amount of reactant, given amount product (or other reactant)

review/recall: chemical eqn

ex $N_2 + 3H_2 \longrightarrow 2NH_3$

conversion factors

problems

(1) $N_2 + 3H_2 \longrightarrow 2NH_3$

2 mol — excess — ? mol

2 mole N_2 = ___ mole NH_3

$$2 \text{ mole } N_2 \times \frac{2 \text{ mol } NH_3}{1 \text{ mol } N_2} = 4 \text{ mol } NH_3$$

(2) N_2 + $3H_2$ → $2NH_3$

excess 2 mol ? mol

3 mol H_2 = ___ mole NH_3

$$3 \text{ mol } H_2 \times \frac{2 \text{ mol } NH_3}{3 \text{ mol } H_2} = 2 \text{ mol } NH_3$$

(3) N_2 + $3H_2$ → $2NH_3$

excess 5 g ? mol

$$5 \text{ g } H_2 \times \frac{1 \text{ mol } H_2}{2 \text{ g } H_2} \times \frac{2 \text{ mol } NH_3}{3 \text{ mol } H_2} = \frac{10}{3} = 3.3 \text{ mol } NH_3$$

(4) N_2 + $3H_2$ → $2NH_3$

excess 8 g ? g

$$3 \text{ g } H_2 \times \frac{1 \text{ mol } H_2}{2 \text{ g } H_2} \times \frac{2 \text{ mol } NH_3}{3 \text{ mol } H_2} \times \frac{17 \text{ g } NH_3}{1 \text{ mol } NH_3} = 17 \text{ g } NH_3$$

ch 3.7 limiting reactant & % yield

limiting reactant:

- limits or determines the amount of product(s) in a Rx

ex $3H_2$ + N_2 → $2NH_3$

5 g 20 g # g ?

method 1: "tedious"

"steps"

i) determine the amount of a product, where assume a specific reactant is the limiting reactant

ii) determine the amount of the product where the "other" reactant is limiting

iii) answer = limiting reactant produces the least amount of product

$$3\,H_2 + N_2 \rightarrow 2\,NH_3$$

5 g — 20 g — ? g

i) $5\ \text{g}\ H_2 \times \frac{1\ \text{mol}\ H_2}{2\ \text{g}\ H_2} \times \frac{2\ \text{mol}\ NH_3}{3\ \text{mol}\ H_2} \times \frac{17\ \text{g}\ NH_3}{1\ \text{mol}\ NH_3}$

$\approx 28.3\ \text{g}\ NH_3$

ii) $20\ \text{g}\ N_2 \times \frac{1\ \text{mol}\ N_2}{28\ \text{g}\ N_2} \times \frac{2\ \text{mol}\ NH_3}{1\ \text{mol}\ N_2} \times \frac{17\ \text{g}\ NH_3}{1\ \text{mol}\ NH_3}$

$\approx$ **24.3 g NH_3**

method 2: "think"

i) pick a reactant, then determine the amount of the other reactant needed to react with the "selected" reactant

ii) compare amount of the other reactant present versus amount needed

iii) identify the limiting reactant based on preceding comparison

iv) calculate amount of product

$3\,H_2 + N_2 \rightarrow 2\,NH_3$

5 g 20 g ? g

a) pick H_2 → # g N_2 needed?

$5\ g\ H_2 \times \frac{1\ mol\ H_2}{2\ g\ H_2} \times \frac{1\ mol\ N_2}{3\ mol\ H_2} \times \frac{28\ g\ N_2}{1\ mol\ N_2}$

≈ 23.3 g N_2 needed (to react with 5 g H_2)

have 20 g N_2, where there is not enough N_2 → N_2 is limiting

blah blah - see above yellow highlighted text

b) pick N_2 → # g H_2 needed?

$20\ g\ N_2 \times \frac{1\ mol\ N_2}{28\ g\ N_2} \times \frac{3\ mol\ H_2}{1\ mol\ N_2} \times \frac{2\ g\ H_2}{1\ mol\ H_2}$

≈ 4.3 g H_2 needed (to react with 20 g N_2)

have 5 g H_2, so ∄ access H_2

so N_2 is limiting . . .

blah blah

% yield

yield: amount of product in a Rx

$$\%\ \text{yield} = \frac{\text{experimental yield}}{\text{calculated yield}}$$

Problems

(1) $C_2H_6 + O_2 \longrightarrow CO_2 + H_2O$

10 g 10 g 4.0 g

find % yield

blah

(2) $C_2H_6 + O_2 \longrightarrow CO_2 + H_2O$

30 g 20 g ? g

assume % yield = 75%

blah